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the independent journal of energy conservation, building science & construction practice

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A reading of ancient history includes tales of leaders going to the local oracle or soothsayer to get a blessing or a vision of what the future would bring. We laugh at stories of the ancients reading the entrails of a freshly slaughtered animal, as if that would reveal the answer. Today, at the dawn of a new millennium, at a time when we live by the computer and travel to the moon and beyond, we think we are above all that hocus-pocus. After all, we don't offer up animal sacrifices or virgins on the altar anymore.

Or do we? Don't we elevate fortune telling into a voodoo science and bestow Nobel prizes for the most brilliant practitioners of the art? I refer to our placement of economics onto a pedestal and calling it a science. As a society, we rely on economic forecasts as gospel. Poking fun at economists has also become passé. However, no self-respecting decision-maker dares make a move without first consulting his oracles (read economists) for the appropriate signs.

I don't mean to be harsh on economists. However, economics is not a precise science as we understand it, but an interpretative art.

This subject came up in a recent conversation I had with a colleague about the recent increase in natural gas prices. The BC regulatory body gave the gas utility permission to pass on the price increases, so gas prices shot up 30%.

It was only a few years ago, when the Model National Energy Code was being reviewed, that strong opposing voices were raised against any measures that would mandate improved energy conservation standards. The main arguments were that housing affordability would be compromised by requiring higher levels of insulation (ignoring the fact that developers are not building "affordable" starter houses).

While operating costs were not considered significant, the argument was made that any change or upgrade to standard practice that the code would introduce would have to be justified on a life cycle costing analysis. Many cost analyses were done. Current energy prices were used with estimated inflation escalators. However, the entire price discussion ignored any meaningful discussion or recognition of the fact that energy prices are subject to non-economic political whims. No forecast allowed for any increases remotely close to the 30% increase in gas prices we have seen in BC this summer.

The consequence is that the standards in the energy code are based on outdated fuel costs rather than more fundamental values of energy conservation.

The recent price increase is being touted as a short-term aberration, but natural gas is a non-renewable fossil fuel. Using up gas reserves faster by increasing pipeline capacity and drilling more wells, will only speed the day when even this energy option is eliminated. Personally, I don't think this price increase is short term. Natural gas is increasingly being used in applications other than for building and industrial use. We are seeing more electricity generated by gas, and more natural gas used in transportation. These changes will continue in the future because natural gas is a cleaner fuel, and there is more competition for available resources.

We need to consider inherent values and sustainable principles when setting standards, and not just look at short-term prices. When talking with economists, and looking at their forecasts, we must be prepared to ask lots of questions. After all, they are no more accurate than your interpretation of the tea leaves in your teacup.

Richard Kadulski,
Editor

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Water Treatment and the Water Crisis

Today, more than two thirds of the world is facing a water crisis. Most people do not have adequate amounts of water - never mind clean water. Severe depletion and pollution of lakes, rivers and ground waters are now commonplace. Even rainwater requires treatment, and not just in industrialized areas.

Canadians have generally regarded their water resources as cheap, reliable and plentiful. Contrary to current belief, Canada does not possess the world's largest reserves of fresh water - China actually has more, but because of its large population it has severe water quality and availability problems.

Parts of Canada's north already have a water crisis. There may be access to plenty of water, but often the water is badly polluted due to decades of careless forestry, industry, storm water, and sewerage practices. Worrisome examples include the all too common discharges of agricultural and industrial wastes, not to mention the extensive mismanagement of storm waters that puts sewage directly into rivers, lakes, or oceans.

In cities, water and sewage needs are generally met by large conventional centralized treatment facilities. Storm water and fire water services are also included in such infrastructure. The accepted practice for potable water distribution systems is based on chlorination, and treatment to clarify water. Small community and rural needs are usually met by individual wells and septic systems (the original basis for the large, 2 acre North American suburban lots).

Chlorination is not sufficient to treat the several micro-organisms present (e.g., giardia, cryptosporidum, toxoplasma). High tech solutions like membrane filters are effective but expensive, and often require skilled maintenance not easy to find in remote areas. Fortunately, there are also non-chemical, lower-tech alternatives like slow sand filters and ozonisers.

Drinking water quality, although nearly always safe, has been of such a quality as to encourage taste conscious consumers to purchase increasing quantities of bottled water. Questions are being asked about the impact of conventional water treatments on our health - for example, chlorine derivatives and trace levels of aluminium.

It is generally acknowledged that much of Canada's municipal infrastructure requires replacement or repair. This may be an appropriate time to review how we handle water treatment, and consider new approaches to it.

CMHC's Healthy Housing initiative has identified commercially viable and available technologies for on-site water and wastewater treatment plus on-site water reuse. Although these are of special interest for small northern and arctic communities, they may be equally suited to southern and even larger urban areas.

The smallest systems are suitable for single houses, but apartment-sized units are under development. Essentially, these are comprised of point-of-use "micro-systems" that offer cost-effective alternatives to conventional centralized infrastructures. While they can be used in place of the large central system, it is more likely that they will complement existing water treatment by reducing the system load, or permit new and less costly types of infrastructure and service networks to be developed.

These micro-systems also draw greatly reduced amounts of water (not water usage by the family) due to on-site reuse of reclaimed water. It is now possible to treat waste water to the degree that it is no longer effluent. In fact, the effluent is of a quality that the treated water can be discharged directly to the local environment - without requiring further sewage treatment or piping. Depending on how much water is reused, it is now possible to reduce water draws by 75-95%. Dutch communities have achieved such reductions in water draw.

Innovative systems can be less expensive than many conventional systems because of on-site water reuse, and the fact that they only have to process 25% or less of normal water/wastewater volumes. Current costs for some of these point-of-use micro-systems are already competitive for urban and suburban installations. In southern regions, they cost $2-4,000 per house for potable water treatment (excluding cistern storage), and $8-9,000 per house for wastewater treatment (excluding a 270 sq. ft. or smaller discharge field). For rural and remote installations in northern and

Types of Waste Water Treatment

Primary treatment: the mechanical removal of wastes

Secondary treatment: using biological processes, or bacteria to break down wastes

Tertiary treatment: using chemical treatment that remove additional contaminants.

arctic regions, these costs may be double. By comparison, conventional municipal sewer and water services can cost $25,000 per house plus $4-10,000 for hook-up charges.

In rural areas, the cost of a conventional septic tank and tile field installation may range from $4-8,000 for a single family residence. Unfortunately, many septic systems perform poorly or are at the limits of their capacity during winter, thaw and storm conditions.

In one case, when the septic systems failed in Ontario's King Township, the cost to hook up houses to a regional sewer system was estimated at $70,000.

In arctic regions, the cost of conventional sewer and water services may be higher (as much as $200,000 or more per house), unless trucks are used to supply water and remove sewage. Monthly costs of truck-haul service in the North West Territories range from $200-900 per family.

The innovative micro-sewage treatment developed for the Toronto Healthy House is being evaluated by the Northwest Territories Housing Corporation in ten houses near Yellowknife and in Cape Dorset. Another system has been installed by a private builder in Iqaluit, and seven more are targeted for Repulse Bay.

Another unique approach to providing treatment for remote housing will be evaluated in a demonstration Healthy House built at Eagle Lake, near Thunder Bay. CMHC is participating in an industry-led consortium to develop a combined heating and utilities module. The goal is to provide a removable/portable water, sewer, heating and electrical infrastructure suitable for individual houses or clusters of houses. The success of this type of initiative will make it easier to build houses that are not connected to conventional treatment infrastructure.

The 4 R's of Wise Water Use

The average Canadian uses about 120,000L (26,396 gal.) of water per year. At least half of which is unnecessary and wasteful. As builders and designers, we need to encourage efficient water use. Reducing how much water is used doesn't have to be difficult - it is as easy as changing the way water is used and ensuring leaks are repaired.

Keep the 4R's of wise water use in mind every time you turn on the tap:

Reduce the amount of water used.

Retrofit - Replace water-guzzling toilets and appliances with more water efficient models. Today's ultra low flow toilets have been re-engineered to work effectively with a fraction of the water of older models. Discourage recycling old, water-consuming toilets.

Repair - Stop the leaks. A leak of one drip per second wastes 10,000L (2,167 gal) of water over one year; enough water to fill more than 60 bathtubs.

Reuse - Consider water reuse technology. The most likely water reuse technology in the future is using grey water from tubs, sinks, and washing for irrigation, and toilet and urinal flushing. On-site water reuse is generally accepted in Japan, Australia and United States, but in Canada this approach to water efficiency is still relatively unknown.
The Toronto Healthy house demonstrated that it is technically feasible to reuse and recycle water on-site. Although the technologies may seem expensive, there are many situations where they may be cost effective. Candidates for detailed consideration of on-site water treatment systems are difficult to reach areas with high service costs.

Using Water Efficiently

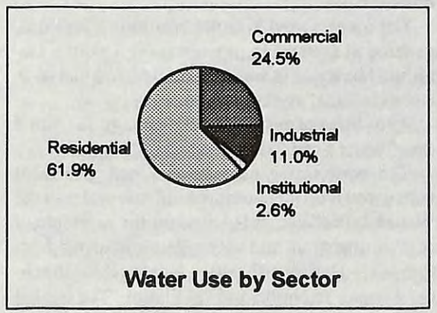
We can live several weeks, even months, without food, but only a few days without water. We need at least eight glasses of water each day. Drinking water or other liquids provides only half the water we need; the other half comes from the food we eat. Recent tragic events in Ontario have heightened our awareness of the vulnerability of our water supply.

We do not really appreciate that the fresh water that sustains all life on this planet is continuously recycled. Water is used, purified, and reused in an endless water (or hydrologic) cycle. Although three quarters of the earth's surface is water, the amount of useable water is limited. It is reused continuously - and is not something we can make if we run out of. In fact, only about 1% of all the water on this planet is available to support life, and most of this is found deep underground in natural reservoirs. Only one third is surface water such as lakes and rivers.

If we continue to use water wastefully and pollute it, we compromise Mother Nature's cleansing and recycling process. The more water we use, the more sewage we produce, and the more chemicals are used to purify water and treat sewage, increasing chemical loading of lakes and rivers.

Many policy analysts have identified that access to water is going to be the source of major world conflicts in coming years. If we want to leave a better world for our children and their children, we must develop technologies that are less reliant on mass water use, and that can process waste water efficiently.

CMHC has published an excellent overview document, ***The Household Guide to Water Efficiency***, which provides a consumer friendly outline of the problem with suggested solutions. It includes household water use indoors and outdoors.



Water Use by Sector

Outdoor water efficiency is perhaps the most challenging issue. Although we see ourselves as a cold northern country, we do enjoy our summers. Our image of the perfect landscape is an image from afar - lush tropical gardens that incorporate high maintenance exotic plants.

The most outlandish examples of water inefficiency are the lush green lawns and golf courses in arid areas, such as the Okanagan Valley or the prairies. These generally include vegetation better suited to the cool, temperate and wet climates of the West Coast or England.

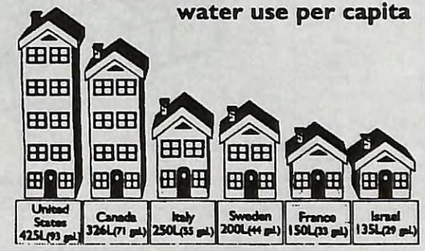
However, it is possible to have very lush gardens that are also water efficient, provided appropriate plant material is used. Xeriscaping, or water efficient landscaping, uses vegetation suitable to local conditions.

The CMHC guide includes a big section on water efficient landscaping. It would be a good idea to provide a copy of this book along with the homeowner's manual. Get your customers thinking about their gardens, too. Suggest they review this landscaping approach to the layout of their garden.

Builders who offer fully landscaped projects should discuss the garden design with their landscape designer to ensure the design incorporates Xeriscaping principles. They not only conserve water, but are also more durable and require lower maintenance.

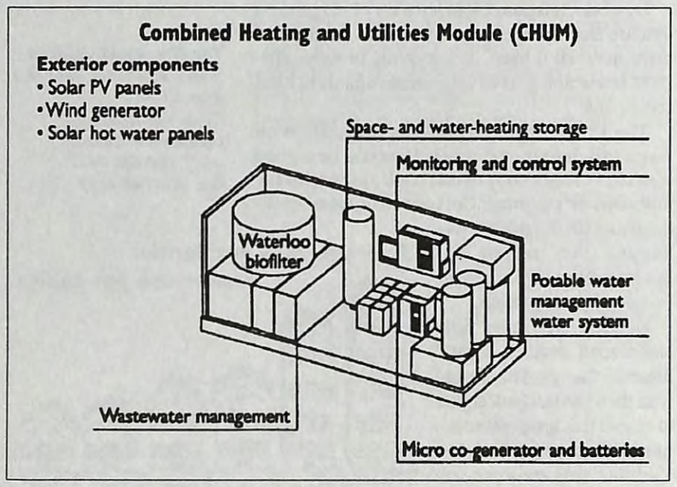
The Household Guide to Water Efficiency available from CHMC.
Canadian Housing Information Centre,
tel: 1-800-668-2642
fax: 613-748-4069

Average daily residential water use per capita

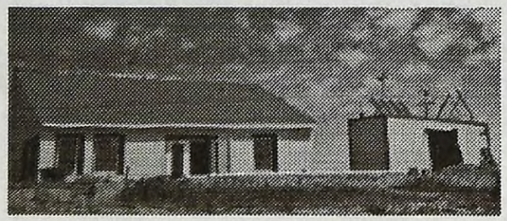


ECO-nomad™ Combined Mechanical Utilities Container

ECO-nomad has been developed to meet the challenge of remote and difficult-to-service properties. It is a combined mechanical utilities package designed to provide all heating, electrical, potable water, and wastewater treatment requirements for single residential and small commercial buildings. ECO-nomad combines existing and proven technologies in a unique and efficient package, eliminating the need for conventional utility grid services, and is portable so it can be transported into place.



A proof-of-concept version has been designed specifically to operate with a well-insulated passive solar home built at the Eagle Lake First Nation in northern Ontario. It was put in to service this spring, and will be monitored for at least a year.


Eagle Lake Healthy House. The ECO-nomad unit can be seen on the right, next to the house.

The Eagle Lake Healthy House has been equipped with a propane range and dryer, electricity conserving light fixtures, washing machine, refrigerator, and various other options to reduce the home's overall electricity requirements.

Although designed for efficiency, durability, and practicality, the ECO-nomad does require maintenance. The homeowner/occupant can do most basic maintenance tasks, and a maintenance agreement to do diagnostics and incidental major repairs by trained technician is available.

A computer monitoring system ensures that the homeowner and maintenance personnel are aware of any potential problems, and is able to remotely diagnose, and sometimes repair, a problem. Safety features include fire detection and suppression, overflow alarm safety lighting, and emergency venting to protect the homeowner and service personnel in case of an emergency.

The proof-of-concept ECO-nomad was developed as the result of collaboration between Architectural & Community Planning Inc., Canada Mortgage and Housing Corporation (CMHC), and Eagle Lake First Nation. It has received CSA equivalent approval following an inspection by the Electrical Safety Authority in Ontario.

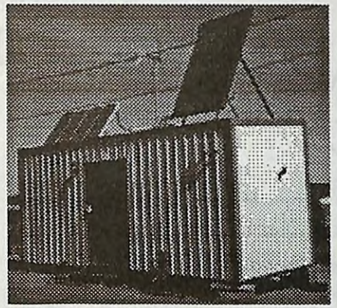
A small diesel co-generation engine produces both electricity and heat. Heat from the engine coolant is transferred to the hot water storage tanks. The electricity generation system gives the house a 4-Kilowatt 120-volt, 60-amp service. This is supplemented by a wind generator that produces electricity at wind speeds of 15 to 25 mph. Photovoltaic panels reduce the overall runtime and fuel consumption of the diesel engine. It is expected that up to 20% of electrical requirements will be provided by solar and wind energy. A solar hot water panel is used to supplement the co-generator.

A 230 US gal (875 L) hot water tank stores hot water for the in-floor radiant heating system and domestic use.

Hot water is used in radiant in-floor, baseboard, or fan-coil systems to provide space heating. Domestic hot water is supplied on demand just as in a conventional system.

3500 litres of potable water, enough for 5 to 7 days' water needs, is stored in holding tanks.

The wastewater management and treatment system can treat all household effluent and uses the Waterloo Biofilter. It is based on the principle of aerobic digestion, and uses a plastic foam medium to provide a large surface area for microbial attachment, water retention and ventilation. The treated and re-circulated water from the Waterloo Biofilter enters the recycled non-potable water and is stored for use in toilet flushing.


Close up view of ECO-nomad unit. panel on the roof at right is the solar water heater collector, while roof mounted panel on the left is the photovoltaic panel for solar electricity generation.

The house plumbing is conventional, but water saving features are integrated.

Under the Ontario Building Code (sections 7.1.6.3 (2) and 7.7), non-potable water can be used for toilet and washing machine application. Piping for non-potable water has to be clearly identified and spatial separation between appliances using potable and appliances using non-potable water has to be maintained.

The Health inspector was hesitant, but willing to co-operate. Health Canada will sample and test the water for one year.

Water stored in the holding and head tanks will flow through a combination of a slow sand filter, 1 micron ultimate filter, and a UV light disinfection unit. These are proven technologies for removing potentially harmful biological organisms, organic and inorganic compounds, sediment, and foul odours and discolouration.

Architectural and Community Planning Inc. maintains all intellectual and licensing rights, and is the producer and distributor of the ECO-nomad combined mechanical utilities container.
Information:
Udo Staschik
Architectural & Community Planning Inc.
Kenora, Ontario
(807) 547-3304

How much water do we use?

The American Water Works Association has completed a three-year study on residential water usage in 14 cities in the United States and Canada. The object was to find out what proportion of total water use is accounted for by specific water-using devices and fixtures. The AWA also wanted to see if water use varies between homes, what factors influence residential water use, and if water use differs in households equipped with water-conserving fixtures.

It was found that water use varied depending on the climate, ranging from 191 gallons per day in Cambridge, Ontario to 835 gallons per day in California. Outdoor water use in hot climates, (such as California and Arizona), ranged from 59 to 67% of the total use, while in cooler, wetter climates the range was from 22 to 38% of the total use.

Showers are used at an average of .75 showers per person per day, and faucets are run an average of 8 minutes per person per day. Daily indoor water use was 69.3 gallons per person. In households without water-efficient fixtures, the average was 72.5 gallons per person per day. Daily use by each fixture is shown in the attached table.

Daily Indoor Water Use

Fixture	*US gallons per person per day*	
Toilets	20.2	27.7%
Clothes washers	15.1	20.9%
Showers	12.5	17.3%
Faucets	11.1	15.3%
Leaks	10.0	13.8%
Baths	1.2	1.6%
Dishwashers	1.0	1.3%
All other indoor uses	1.5	2.1%

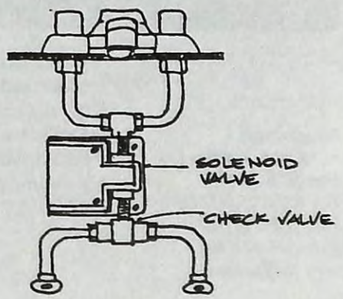
Anti-scald faucets

Scalding accounts for about 20% of all body injuries, and is the most frequent cause of non-fatal burn injuries to children in North America.

A retrofit kit that can convert a standard faucet into a hands-free, anti-scald faucet has been developed by SmartWave Technologies. An electronic mechanism automatically shuts off water flow when the temperature reaches a preset limit determined by the user, thus preventing scalding. It also lowers water consumption by using electronic temperature sensing technology to control water flow. The passive detection technology provides hygienic and energy efficiency benefits of hands-free use.

The Touchless Smart Faucet is available through plumbing wholesalers.

Information at www.smartwave.ca
SmartWave Technologies Inc.
Tel: 416-679-5050

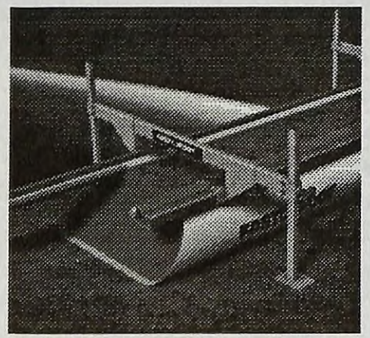


Fabric Forms for Footings

Traditional concrete forming requires considerable amounts of lumber and framing labour, yet all the work is done only as a temporary container for the concrete until it cures. Once the concrete sets, the forms have to be stripped, at which point much of the forming lumber is damaged beyond salvage. All of this entails labour and material cost. As a result, there is an increasing move toward alternate ways of forming.

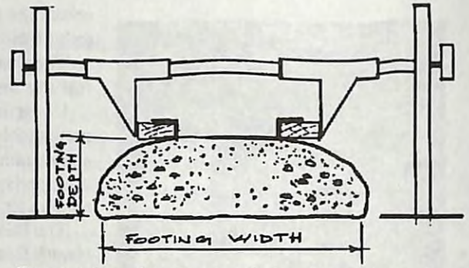
For example, in large-scale commercial construction, metal forms are often used. A new approach is using fabrics. The flexibility of fabric forms means little or no ground levelling or trenching is required because the footing conforms perfectly to uneven ground. Footings and pads can be formed to any desired width and height at a fraction of the cost of conventional lumber.

Fastfoot Industries of Surrey, BC has developed a system that relies on reusable, infinitely adjustable yokes. The fabric form material is stapled to 2x4s held in place by the yokes for the pour. It is quick to install (the manufacturer claims that up to 100 lineal feet of forming can be placed per hour), and light weight - 120' of fabric weighs 13 pounds, compared to 800 pounds for lumber. Stakes are not needed and there is minimal stripping. With an accurate footing layout, secondary wall layout is not needed because the 2x4s can be used as the wall kickers.



The system can be considered "environmentally friendly" because it offers huge savings in the amount of wood-products used vis-a-vis conventional systems. Because the strip form material is a woven polyethylene fabric, it also acts as a capillary break, reducing the amount of ground water that will be drawn up into the concrete.

We have heard that some building officials are concerned about fabric forming, largely because of its radical appearance. However, the Building Code does not mandate the process of construction, but the finished structure. Fabric forming is simply a forming system that makes the construction process easier. Whether it works satisfactorily or efficiently can best be judged by the contractors who use it.



Cross section of the Fastfoot footing has an unusual section, although it does have adequate bearing capacity.

Despite the footings' unusual shape, they are really no different than conventional engineered footings with sloped top surfaces. The important feature is that the footing has the critical depth and width needed for the loads imposed on it. Forming systems have traditionally been straight and rectangular because of the nature of forming materials used, and because design drawings originated in offices where set squares and rules were used to prepare them. Before the use of Portland cement, footings were often irregular in shape because they were made from stone and rubble mortared together.

Contractors can save on labour and lumber costs and use less concrete with fabric forms instead of wood. Pad footings are also available. These are pre-sewn fabric bags filled with concrete. The amount of concrete pumped into the bag determines the thickness of the footing. The ground does not have to be levelled since the concrete-filled fabric conforms to uneven surfaces. If steel reinforcing is required, bags with zippers are available which allow reinforcing bars to be placed inside the bag. When the concrete has set, there is nothing to strip because the fabric remains in place. The bags come in a range of sizes from 18 to 48-inch square sizes.

Information:
Fastfoot Industries Ltd.
Surrey, BC
Tel: (604) 596-3278 toll free: 888-303-3278
Fax: 604-501-6090
www.fastfoot.com

Old to New: Design Guide

Salvaged Building Materials in New Construction

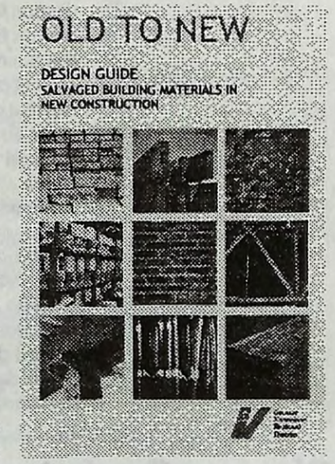
Sustainability in general has emerged as a necessary guide to human endeavour. Environmental sustainability requires gaining greater utility from all resources before returning them to nature. Improving the performance of new buildings, making them more energy and resource efficient is only a start. Buildings must also have the potential to be recycled and reused.

We must reconsider how we design, build and use buildings. The challenge is to make use of materials that are already available, and when buildings must be removed, that they be deconstructed rather than merely junked and put into landfill.

Greater Vancouver has faced major development pressures over the past half century. Waste management is a major problem. Local landfills are nearly full, and some solid waste is trucked to a landfill more than 300 km away.

Because construction waste is the largest part of waste going to landfills, a major effort has been made to divert it away from landfills. A comprehensive jobsite recycling program has been in effect for a number of years.

A new initiative just completed recently is an illustrated Design Guide to using salvaged building materials. The guide's purpose is to provide architects with practical information to encourage and facilitate the use of salvaged building materials in new construction projects.



The guide contains case studies of recent projects in the Vancouver area that used extensive quantities of salvaged materials. These are not small residential projects, but industrial and institutional projects. The case studies include a description of the salvaged materials used, their source, and a project timeline. Also discussed are issues that must be considered at the design stage, and how a project can be structured. The section on salvaged materials is laid out in standard 16 division construction specifications format. Materials availability and sources are included in each section.

While the guide was prepared specifically for the design community in the Greater Vancouver area, and contains many local references, the information it contains will be useful to a wider audience interested in reusing salvaged building materials.

***Old to New: Design Guide to Salvaged Building Materials in New Construction**, prepared by Paul Kernan, MAIBC, Richard Kadulski, MAIBC and Michel Labrie for the Greater Vancouver Regional District.*

Copies of the guide are currently available for residents of the GVRD at no cost. For those outside the GVRD, the Guide is available for $45 per copy, which covers duplication and handling costs. For information, contact:
Thomas Mueller
Greater Vancouver Regional District
Tel: 604-436-6818
Fax: 604-436-6811
e-mail: Thomas.Mueller@gvrd.bc.ca

Reasons to Consider Use of Salvaged Materials

- Demonstrate leadership and innovation.
- The quality of salvaged materials, especially lumber, is often better, resulting in a better building.
- Cost. Salvaged materials are often cheaper; they definitely do not cost more.
- May produce unique features in building design.
- Green buildings can be a marketing advantage, especially as public opinion and awareness of environmental issues is changing.
- Buildings can incorporate historical associations.
- Performance is equal to that of conventional building.

Air Sealing Houses to Control Intruders

Houses are being built more airtight. The increased airtightness came about due to changes in construction methods and materials. Another motivation for change was the added benefit of energy savings from airtight construction. A side benefit, and a more important one, is that properly built, airtight construction is more durable construction. Airtight construction reduces the leakage of warm moist air from the interior, which can condense and lead to premature structural deterioration.

We also have to remember that the building envelope is part of a system. All parts are integrated, and work as a whole. Properly detailed, airtight construction also reduces exterior moisture penetration into the building envelope. If the building is airtight, it will also be watertight. In other words, the tighter the building, the less water will get through.

Another, lesser-known benefit of airtight construction is that if there are no holes, it will be more difficult for "intruders" to enter the house. The intruders can be insects, or more substantial animals like rodents. This is not just an issue of aesthetics or human fear. It can have serious health effects. Rodents are carriers of toxic viruses and illnesses, some very serious, such as the hanta virus that is spread by deer mice.

If most of the ventilation is provided by a heat recovery ventilation system, the number of air borne insects (mosquitoes, flies, and other bugs) are also reduced. If you have doubts, just ask whoever has ever cleaned an HRV in the fall. When the unit is opened, a large number of dead bugs will be found on the supply air filter.

The third party certification of R-2000 houses provides a measure of certainty that a house as-built will indeed be airtight, thus reducing the chances of letting in unwanted occupants.

Slab-on-Grade Insulation: How Much Is Required?

The heat loss through an un-insulated radiantly heated slab can be reduced by as much as 46% if insulated with 2" (R 8) of expanded polystyrene (EPS).

We know that heat flows from a warmer area to a colder one, whether up, down or sideways. But because the perception persists that soil is a good insulator, basements and floor slabs do not get insulated to levels they should. This is especially important in buildings where floor radiant heating is installed.

Installing a hydronically-heated slab-on-grade without insulation under it makes about the same sense as installing a single pane window in a new house. Yet resistance to using insulation below concrete slabs exists in part because there has not been much research on heat loss through floor slabs. The limited information available suggests that little insulation is needed in this location for energy savings.

Most recommendations for sub-slab insulation are based on unheated slabs. However, heat loss through radiantly heated floors is so much higher than through unheated slabs, that the normal rules and practice for insulating unheated slabs clearly do not apply to radiantly heated ones. However, there is no published research on heated floor slabs. In addition, many concrete slab-on-grade floors are placed over wet soils (which are highly conductive) or over high water tables (which are very high capacity heat sinks). Clearly, more insulation is required for heated slabs, but how much?

Dr. John Straube from Waterloo did a series of computer simulations to determine the energy savings that could be achieved using below slab insulation in heated slabs. The simulations modelled two common foundation/basement situations: a range of insulation values, and a range of soil properties. Since it takes about three to five years to stabilize soil temperatures under a slab, the study took the fifth heating season for the calculation period.

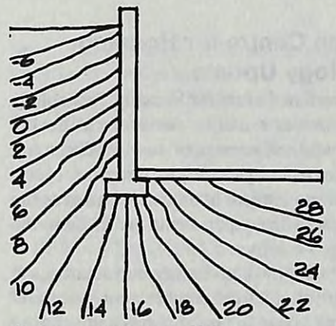
As can be expected, under-slab insulation can significantly reduce heat loss. In an un-insulated heated slab, almost half the purchased energy is lost to the soil. The size of the energy savings will depend on many variables such as climate, house design, floor finishes and soil properties. For example, a floor finish that is a good insulator (like carpets) will require higher slab temperatures to provide enough heat into the house. The hotter the slab, the more heat lost to the soil.

Surprisingly, there is not a big difference in heat loss between a slab-on-grade and a basement floor 6 feet below grade. The heat loss for a slab on grade is only about 15% more for the full basement floor. The additional 6 feet of soil is not an effective insulator.

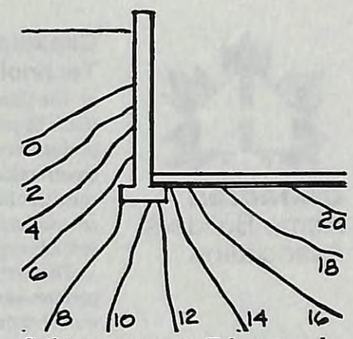
The heat loss through an un-insulated radiantly heated slab can be reduced by as much as 46% if insulated with 2" (R 8) of expanded polystyrene (EPS). Three inches (R 12) could be expected to reduce sub-slab heat loss by more then 50%.

Another important issue is the slab edge insulation. A piece of 4" high and ¾" thick EPS between the slab and the foundation wall is likely the most effective piece of insulation in the entire house. If possible, this insulation between the heated slab and the unheated wall should be at least 1" thick.

This study was commissioned by Beaver Plastics, an Edmonton-based manufacturer of EPS insulation products. They wanted to have some scientific evidence to be able to answer questions commonly raised. However, the information is based on 2" of generic EPS insulation.



Soil temperatures in February under an uninsulated floor slab



Soil temperatures in February under an insulated floor slab

Effectiveness of Beaver Plastics' INSULWORKS insulation system used below radiant floor slabs. *Prepared for: Beaver Plastics, Edmonton, Alberta, Canada by: Dr. John Straube and Chris Schumacher of John Straube Building Envelope Engineering, Waterloo, Ontario, Canada*

The full report can be found on the Internet at www.beaverplastics.com

R-2000

For information on the R-2000 Program, contact your local program office, or call 1-800-387-2000

Letter to the Editor

Re: Building Durability, Design Life and Maintenance (Solplan Review No. 92, May 2000)

I would like to make an observation. You cannot buy any shingles here with less than a 20-year life. Shingles with a 10-year life have not been available for some time. I would think the range should be more like 20 - 40 years.

Also, the standard warranty for membrane readings is 10 years with the odd exception to 20 years by special product. 10 to 12 years is probably a more likely range. Also, there can be some maintenance if there is moss growth, high winds, etc. I am not criticizing, just trying to help update and make the information as accurate as possible.

Doug Harrison,
Advanced Energy Group
Delta, BC

Thanks for the note. While you are correct about the materials being sold, I understand that, in practice, the life span of various products does vary. In some regions, especially those with hot intense summer sunshine, dark-coloured roof shingles seem to deteriorate prematurely while light-coloured ones last longer. In addition, contrary to perceptions of natural durability, cedar shingles can deteriorate in less than ten years.

The important point to keep in mind is that the actual life span will vary depending on many factors, including climatic stresses, installation practices, and design features. The life span may be longer or shorter than manufacturers' claims. Even though we rely on a product's rated durability, actual product performance may not always meet our (or manufacturers') expectations. Ed.

Technical Research Committee News

Canadian
Home Builders'
Association

Canadian Centre for Housing Technology Update

The Canadian Centre for Housing Technology (CCHT) provides a unique environment for the evaluation and refinement of new products and construction techniques. Right now, the centre consists of two identical houses: one is used as the control house when experiments are made in the second.

The first major test underway is evaluating the performance of gas fired combination space and water heating systems. The combo systems consist of a gas water heater and an air handler. Heat from the water tank is transferred to the air pushed through the fan coil in the air handler. The remainder of the space heating system is a conventional ducted system.

The water heater efficiency of several units was tested over a 12-week period. A sophisticated computer program simulated regular occupancy - turning water taps on and off, drawing water to simulate showers, baths, washing clothes and operating lights and other appliances.

The tests are for specific systems, but the information obtained will also be used to draft a technical standard for combo systems.

Other tests underway or scheduled include evaluating basement construction, automatic window blind systems, and radiant paint performance.

Ventilation systems

Old timers in the industry may find it hard to believe, but Canadian heat recovery ventilators (HRVs) have now been commercially available for more than 20 years. The idea may not have been new even then, and other products may have been used in Europe before. However, the HRV as we know it has been enhanced and refined in Canada. In some parts of Eastern Canada an HRV is a standard fixture in every new house, but in many others it is still considered an exotic luxury.

Building Envelope Research

Building envelope construction and detailing has received much attention after the problems that emerged on the West Coast. It is interesting to review the work that has been done as a result, and the steps that are being taken to better understand the performance of the elements in a building. Some research now underway will provide a better, more fundamental understanding of the physics of construction assemblies. Other efforts will include technology transfer and education.

The Building Envelope Research Consortium (BERC) was created by industry and regulatory groups to act as a coordinating agency for research into building envelope problems in BC. Its objective is to improve residential construction industry technology and practice through the application of research knowledge.

Activities undertaken or planned include:

Field Survey of Wood Frame Envelope Failures. This was completed in 1996, and laid out the nature and size of the problems the industry is facing.

Best Practice Guide for Wood Frame Building Envelopes for the Coastal Climate of BC. This CMHC document provides design information on wood frame design and construction.

Quality Assurance Protocol for Wood Frame Building Envelopes. This document gives help to the industry on ways to better manage projects in order to reduce the possibility of problems being built in.

Envelope Drying Rates Experiment. This ongoing laboratory exercise is measuring the drying capacity of a variety of wall assemblies. It was created because there is no documented information on the drying performance of various construction assemblies. The survey of failures pointed out that walls with face-sealed or concealed barrier systems do not dry quickly once the wall has been wetted. The exercise is intended to discover what types of details are required to ensure that there is a good drying potential.

Building Envelope Remediation Guide. This guide will provide recommended diagnostic procedures for cost-effective remediation.

High Rise Envelope Details Study. A study will review approaches to high rise construction in order to identify moisture problems.

Leak Proofing Windows. Window design, construction and installation have been identified as a significant problem in envelope construction. This research, which is about to be launched, will review various aspects associated with windows, including design, testing, codes and standards, installation, maintenance, framing, and materials, as well as construction detailing and sequencing of work during construction. It will highlight areas where changes or improvements can be made.

Monitoring the On-site Performance of Exterior Wall Systems. Little research has been done to obtain performance data on exterior wall assemblies in the real world environment. Several walls in real life projects will be instrumented and monitored. This will help diagnose the source of moisture problems and provide appropriate repair strategies.

Sheathing Membranes Durability and Performance. This project will investigate the performance of sheathing membranes, including the interaction of various materials with sheathing products, including wood-based and gypsum-based sheathing materials and wood and stucco additives in claddings.

Model Buildings and Monitoring Building Performance. Several projects will be monitored to review the quality assurance protocols being developed. The design, construction process, and completed building will be monitored. Built walls will also be tested for thermal performance, pressure difference, and rain penetration control strategies. The building performance may be monitored for several years.

Investigation of Mold Exposure Levels in Exterior Remediation. Concerns have been raised that workers may be exposed to dangerous levels of molds when doing remediation work. This study will investigate mold levels against current guidelines to find how much of a problem this may be.

Building Envelope Education Program. This Architectural Institute of BC program, which is a series of 4 courses for a total of 9 days, has now been taken by more than 500 participants. It was developed to raise the level of building envelope knowledge for practicing design professionals.

Tool Box for Builders and Trades. This course for contractors and subtrades will be available later this year. It is intended to provide material on appropriate construction practices for constructing durable building envelopes for new wood-frame construction and repairing existing buildings.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Furnace Filters: do they work?

More than 60% of Canadian houses are heated with forced air. Traditionally, filters have been put in the ductwork to protect the furnace and fans. These filters are often called "rock catchers" by the heating industry. With the increasing awareness of indoor air quality, filters are being installed to reduce occupant exposure to respirable particles.

While a broad range of filters is available, there is no common rating system to help with selection, nor is there industry agreement on which rating system is most appropriate for household filters. Many manufacturers do not give consumers filter performance information, so it is difficult for the homeowner to select a suitable filter and to know what performance can be expected from it. A new ASHRAE filter standard (52.2-1999) that specifies filter performance for specific particle sizes has just been developed, but it will be some time before this standard is used to test filters.

Particles larger than 10 microns (um) are big enough and heavy enough to quickly settle out by gravity. They are not generally breathed in by persons during ordinary activities, so smaller particles are of greater concern. Particles less then 2.5 microns in diameter are commonly called PM2.5 or inhalable suspended particulate. Particles between 2.5 and 10 microns are usually trapped by our nose or throat, so not as likely to be inhaled.

Particles smaller than 1 um are largely influenced by electromagnetic forces and particles between 1 and 5 um are influenced to varying degrees by gravitational and electromagnetic forces.

Although testing standards exist to measure how effective a filter is for a range of particle sizes, there is little documentation on the effect filters have on the particle count in a home under normal operating conditions. In other words, do good quality filters really improve indoor air quality? To answer this question, a project to investigate furnace filter efficiency was done by Bowser Technical for CMHC.

Testing for each filter included measurements of indoor and outdoor particle counts for a variety of filter types. Generally outdoor PM10 levels are similar to indoor levels during periods that people are active, but higher than indoors during non-active periods. Indoor particle concentrations are essentially independent of outdoor levels.

Five filter types were tested in six houses with a variety of occupancies, locations and dust sources. Testing took place during the winter and early spring to reduce atmospheric dust entry that occurs with open windows during the summer. Each filter was tested for its efficiency, clean air delivery rate, for cumulative indoor particle concentrations and personal particle exposure. Because the filters were in each house for only a few days, the study could not answer questions about the effects of filter loading or long-term particle counts inside the house.

The five filters tested were:

- a medium-cost 25mm pleated filter with factory-applied passive electrostatic charge;
- a DC-current, charged-media type;
- a 100-mm pleated media filter;
- an electrostatic precipitator or "electronic" (plate and wire type) filter;
- a bypass filter, either with a HEPA filter or with an internal filter bank.

For each test, results using the filter were compared with results obtained with no filter. It was found that a whole house filter does not automatically result in a corresponding reduction in particulate levels in the house. The particle concentrations peaked during activity periods, no matter what type of filter was in use.

Household dust particle levels can be reduced by:

- ☛ Removing footwear upon entry;
- ☛ Keeping major dust generators (i.e. smoking and pets) out of the house;
- ☛ Reducing dust collecting surfaces (open shelves, carpets, upholstered furniture, etc.);
- ☛ Diligent and frequent vacuuming with an efficient vacuum cleaner;
- ☛ Reducing the entry of particle-laden outdoor air by closing windows, improving air tightness and installing an intake filter on the air supply.

With these lifestyle adjustments, the installation of an efficient furnace filter, with a continuously operating furnace fan would make a significant reduction on the remaining, minimal particle exposure.

Evaluation of Residential Furnace Filters ($12.95 plus shipping and taxes to Canadian addresses)
Prepared for: CMHC by
Dara Bowser
Bowser Technical Inc.

When the home is not occupied and when there is little activity (i.e., during sleep or when no one is in the house) particle concentrations can drop to very low, almost zero levels. During periods of occupant activity, particle levels can increase to levels 10 to 20 times the "at rest" values simply due to movement in the house. For example, peak particle levels during some cooking activities can be up to 100 times the "at rest" values.

Re-suspension and generation of particulate due to activity appears to be the dominant factor affecting an individual's exposure to particulate inside the home. In essence, activity creates a dust cloud that overwhelms background concentrations and will determine the amount of dust. In effect, we are all like the Snoopy character, "Pigpen" under our own dust-cloud.

Dust levels were similar in the same house with no filter. However, during the rest period baseline concentrations were much higher. A good filter will significantly reduce the house concentrations during rest periods.

The most efficient of the filters tested was the electrostatic (electronic) precipitator. This filter does, however, produce ozone during operation - the ozone levels always higher in the ductwork than in the indoor air. But ozone levels measured inside the house never exceeded 20 ppb, which is lower than the Canadian (Health Canada) one-hour residential guideline of 120 ppb. The other filters tested have intermediate efficiency, falling between the no-filter/standard filter baseline and the high efficiency of the electronic filter. To differentiate clearly between these "medium-efficiency" filters would take relative efficiencies from house to house, and a far bigger sample with longer sampling periods,.

This study showed that the amount of particle in the duct system can be reduced when an upgraded filter is installed in a forced-warm air furnace system. The results also showed that the source of particles can overwhelm dust removal by an air filter, so the filter will not necessarily result in a significantly reduced indoor particle exposure.

The research is being continued over with further work on ozone and electrostatic precipitators, the influence of carpets on particulate resuspension, and the ratio of indoor-generated particulate to infiltrating particulate.

Limited testing of portable air cleaners showed that they are highly effective for particulate removal in a single room.

At any point in time, the suspended particle level in an interior space is a function of several variables:

Removal
Setting the rate of the suspended particles (collection by the surfaces in the house); and removal of particles through a mechanical system and filter.

Addition
Re-suspension due to activity of persons or animals in the house;
Entry of particles from the outside due to infiltration; and
Generation of particles by an activity such as cooking (or using candles).

Change in airflow induced by installing a new filter.

The actual change in airflow when exchanging one filter for another is not significant. The most restrictive filter reduces the airflow less that 20% compared with an "ordinary" filter. The best filters result in virtually no change to airflow at any operating speed. There is little significant effect on the air-moving capacity of a normal furnace or air handler for most filters when they are clean and properly sized.

Blower operation directly affects the performance of a central filter. If the blower does not operate, no filtration occurs. Continuous low-speed air handler fan operation is an effective strategy provided the energy consumption is reduced in appropriate proportions. Low-speed operation appeared to reduce the amount of high-speed operation that would otherwise have been required for heating.

Depending on the operating time in the base case, a change to continuous blower operation to achieve improved filtration could result in an increase in annual energy expenses of up to $250.

Bypass filters recorded much higher electrical energy consumption than full-flow systems. The additional expense of a bypass filter could be as high as $120 per year.

Assessment of Filter Types

Ordinary furnace filter		▪ Does not filter respirable/ inhalable particles.
25 mm pleated media filter	At an annual cost of $3.36 per L/s of clean air, does not provide good value.	
25 mm pleated media high quality filter	At an annual cost of $1/13 per L/s of clean air, provides good value.	▪ Readily available ▪ Does not require special installation, power supply or duct modifications
25 mm passive electrostatic filter	At an annual cost of $0.63 per L/s of clean air, provides good value.	▪ Low overall performance ▪ Readily available ▪ Does not require special installation, power supply or duct modifications.
Electronic charged pad	At an annual cost of $1.25 per L/s of clean air, provides good value.	▪ Low overall performance ▪ Readily available ▪ Does not require special installation, or duct modifications ▪ Small power supply may require wiring modification (outlet).
100 mm pleated media filter	At an annual cost of $1.71 per L/s of clean air, provides moderate value.	▪ Moderate overall performance ▪ Requires special installation and duct modifications ▪ Power supply not required.
95% dust spot pleated media filter	At an annual cost of $1.71 per L/s of clean air, provides moderate value	▪ High overall performance ▪ Requires special installation and duct modifications ▪ Not readily available ▪ May restrict airflow if not carefully selected ▪ Power supply not required.
Electronic plate and wire type filter	At an annual cost of $0.26 per L/s of clean air, provides good value	▪ High overall performance ▪ Requires special installation and duct modifications. ▪ Power supply may require wiring modification (outlet plug)
Turbulent flow precipitator (bypass) filter	At an annual cost of $2.29 per L/s of clean air, provides moderate value.	▪ Moderate overall performance ▪ Requires special installation and duct modifications. ▪ Power supply may require wiring modification (outlet plug)
HEPA (bypass) filter	At an annual cost of $2.03 per L/s of clean air, provides moderate value.	▪ High overall performance ▪ Requires special installation and/or duct modifications. ▪ Power supply may require wiring modification

Energy Answers

Rob Dumont

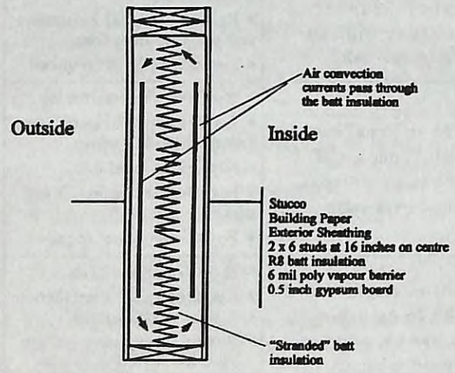
Does insulation always deliver its rated R value?

"*There is many a slip twixt the cup and the lip.*" In other words, no.

Here are a couple of contemporary examples of how insulation performance can be greatly degraded.

1. "Stranded insulation – the R Zero wall"

Figure 1 shows an example of how an R 8 batt can have almost R zero performance. In this example, an R 8 (2.5 inch thick) glass fibre batt is placed in a 2 x 6 stud exterior wall (either steel or wood). The batt does not fill the cavity, nor does it press against either the cavity's outer or inner surface. When a batt is stranded like this, the insulation performance is almost totally degraded. If there is a temperature difference across the wall, as would exist in the heating season, the outer cavity between the batt and the wall becomes colder than the inner cavity between the batt and the inner wall. As a result, convection currents are established which push the warm air on the inner side through the batt insulation into the cold air on the opposite side. The result is that the glass fibre insulation is essentially worthless. The simple act of pressing the insulation against either the outer wall or the inner wall can restore the insulating value of the batt insulation.



Fifure 1

My own preference with 2 x 6 cavities is to completely fill the stud cavity with an R 20 batt so there are no spaces for convection cells. That extra R 12 insulation only costs about 25 cents per square foot, saves both cooling and heating energy, and avoids any possibility of those nasty convection cells.

I have also seen this problem of stranded insulation in masonry construction where a piece of rigid plastic insulation is placed against a concrete block wall that is not straight. Air gaps exist between the insulation and the concrete, and convection cells can readily develop which greatly degrade the insulation value.

Any air gap next to a piece of insulation can develop a convection cell. If the insulation is porous or has air gaps around its perimeter, and can communicate with an air gap on the opposite side of the insulation, the R value of the insulation will be seriously degraded.

Unfortunately the batt insulation is often installed by the lowest-paid person on the construction site, and the effects are readily apparent. Too often you will see insulation batts squeezed behind or around the electrical wiring, insulation gaps around electrical and phone boxes, insulation not cut around the wall blocking, and insulation that is 'punched' rather than fitted into the wall cavity.

2. Thermal Bridges

Steel is a terrible insulator against heat flow. Full stop. All metals have this problem.

Steel stud construction is now very popular, particularly in commercial construction. For a typical 2 x 6 steel stud wall with studs at 16 inch centres with R 20 insulation between the studs, the net effect of the heat conduction through the steel studs is to reduce the overall R value from R 20 to about R 10. In other words, 50% of the insulation value is lost because of heat conduction through the steel studs!

By comparison, a 2 x 6 wood frame wall at 16 inches on centre with R 20 batt insulation has an overall R value of about R 17. Wood is so much better as an insulator than steel that the wood wall shines by comparison.

If you must use steel studs, increase the stud spacing to 24 inches on centre (which will increase the overall wall R value to R 13.7), and add R 5 insulating sheathing on either the outside or inside of the wall (which will further increase the overall wall R value to R 20). Note that, in the latter step, adding R 5 insulation actually adds R 6.3 to the overall wall insulation. This is not a typo!

The Canadian Model National Energy Code for Buildings (1997) has an excellent section (Appendix B) which presents the effective R values for various wall, ceiling and floor assemblies.

Please send any energy-related questions to robdumont@hotmail.com

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Vemiculite Alert

Some reports in the USA have identified cancer causing asbestos fibers may be present in some batches of Zonolite. Some vermiculite batches that originated in a Libby, Montana mine have been found to have as much as 5% asbestos. Although the mine has been closed for ten years, the products from it have found their way throughout North America.

A number of lawsuits are underway.

Renovators in particular should take caution when working with vermiculite products.

NRC·CNRC

Controlling Impact Noise in Residential Buildings

By A.C.C. Warnock

Dr. A.C.C. Warnock is a senior researcher in the Indoor Environment Program of the National Research Council's Institute for Research in Construction.

Most people have experienced the sound of a thump, thud, tap or other impact on the floor above. Whether someone is moving furniture, dragging a vacuum cleaner, dropping a baseball, or walking in hard shoes, impact noise can be quite annoying, especially in multi-family dwellings.

A common measure of a floor system's ability to control impact noise is the Impact Insulation Class (IIC). This measure is derived from standard tests in which a tapping machine with five steel-faced hammers strikes a test floor and generates noise in the room below. The higher the IIC, the better the attenuation of noise, with 50 considered the minimum for multi-family dwellings. Table 1 gives some examples of IIC values for different floor types and toppings.

Concrete-Slab Floors

Soft floor finishing materials that provide a cushioning effect are needed for effective control of impact noise with concrete slabs, which themselves provide poor sound attenuation. Good thick carpet with underlay provides excellent cushioning and high IIC ratings; few occupants will be disturbed by impact noise in this situation. Soft, vinyl coverings, however, are too thin and lack the resiliency to provide effective noise control.

Ceramic or marble tiles attached directly to the slab make for attractive floors but they provide precious little improvement in sound attenuation. When a hardwood finish over concrete is desired, a cushioning resilient layer such as shredded or foamed rubber, foamed plastic or cork mats, must be used in between. Even better impact noise control is achieved by supporting the wood finish on strapping and a layer of fibrous material; this called a floating floor. The floating floor is also the most effective system when ceramic tiles or other hard finishes are to be used.

A concrete top layer (30-100 mm) placed over a layer of fibre board (glass or mineral fibre) gives an even better IIC rating than a layer of wood on strapping.

Table 1. Some approximate IIC ratings.

		Joist Floor*	
Topping	150 mm concrete slab**	Wood subfloor	Concrete topping
Ceramic tiles	28	40	40
Vinyl flooring	37	47	50
Hardwood flooring	33	47	47
9-mm thick wood layer on 6-mm thick resilient layer	47	47	55
Carpet and underlay	75-85	75-85	75-85

* Single-layer subfloor and ceiling.

**A 200-mm-thick concrete slab would increase all IIC ratings by about three points.

For more information on this subject, particularly the differences inherent in dealing with low- and high-frequency sound, readers should consult Construction Technology Update No. 35, Controlling the Transmission of Impact Sound Through Floors, available from IRC: www.nrc.ca/irc/catalogue/ctu.html

Wood-Joist Floors

Gypsum board attached directly to joists, or to wood or stiff metal furring, gives poor impact sound attenuation. A basic joist floor that follows good acoustical principles is one that has resilient metal channels supporting the gypsum board and sound-absorbing batts in the cavity. Common resilient metal channels are adequate for most cases. The key factor is the total mass of the subfloor and the ceiling layers: each doubling of the total mass increases the IIC by about seven points. Increasing the thickness of the sound-absorbing material increases the IIC but to a lesser degree.

Joist floors must still be provided with a finish layer, and an unwise choice can actually increase sound transmission. Hard finishes such as ceramic tiles adhered directly to the subfloor, for instance, reduce the IIC because of the increased generation and transmission of sharp, high-frequency sounds. Thin resilient coverings such as vinyl, while reducing the sharpness of noise, do not greatly increase the IIC of joist floors. (They are somewhat more effective on concrete floors.) Wood or laminate flooring on a thin resilient layer usually does not increase the IIC significantly. Any benefit comes mainly from the added weight of the wood.

High IIC values can be obtained with lightweight joist construction by using a carpet and pad. However, while the IIC rating will be high, such floors may still generate complaints about excessive low-frequency "booming" or "thumping" sounds produced by people walking. The IIC rating does not reflect the degree of annoyance caused by these sounds on this type of floor.

Joist Floors with Heavy Subfloors

A heavier floor vibrates less when walked on, and so it generates less low-frequency sound. Thus, a common approach to reducing the thumping noise associated with joist floors is to increase the mass of the floor by adding a layer of concrete, gypsum concrete or the like on top. But, while this reduces low-frequency thumping, it creates another problem: the sharp clicking heard on any hard surface. In fact, the effect of adding a layer of concrete on top of a basic joist floor is to *reduce* the IIC by several points. The solution to this problem is to "treat" the hard surface of the added concrete layer in the same way as described earlier for a solid concrete slab—with soft floor coverings or floating layers.

Alternatively, a resilient material can be placed between the wood subfloor and the concrete layer. Using this approach, a ceramic or hardwood finish may then be applied directly to the concrete without fear of reducing the IIC.

Coming Events

Sept 21-23, 2000
HRAI 32nd Annual General Meeting
Kelowna, BC
1-800-267-2231

OCT 10-12, 2000
Canada's Energy Efficiency Conference
Ottawa, ON
Tel: 1-877-633-7440 or: 1-613-992-6130
http://oee.nrcan.gc.ca/conference

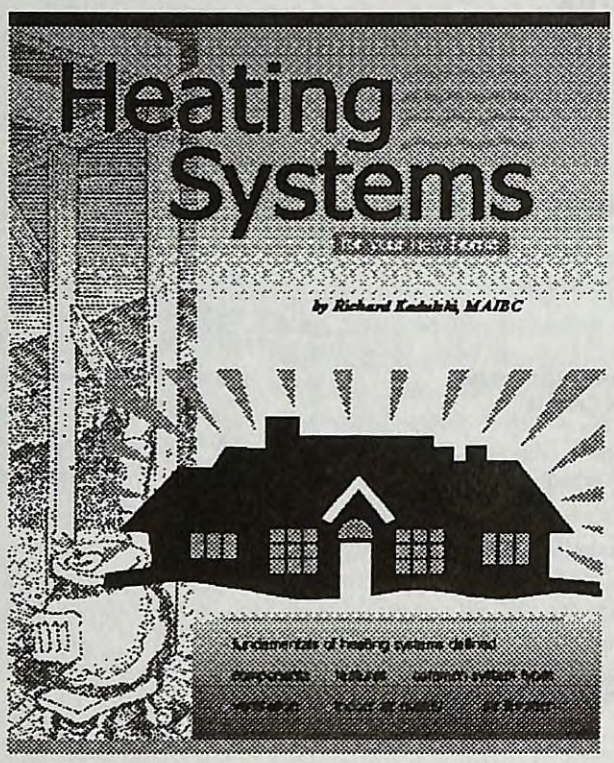
Oct 21-24, 2000
Rise & Shine 2000
26th National Solar Energy Conference
Solar Energy Society of Canada
Halifax, NS
rs2000@chebucto.ns.ca
Www.chebucto.ns.ca/Technology/RS2000/

December 5-6, 2000
Home Performance Strategies
San Ramon, CA
Tel: 800-344-4866
Fax. 724-223-7754

January 17-18, 2001
Ontario Builders Forum
Toronto, ON
Tel: 416-447-0077
Fax: 416-443-9982

April 30-May 5, 2001
Affordable Comfort 2001 Conference
Home Performance Industry conference
Milwaukee, WI
Tel: 800-344-4866
Fax. 724-223-7754

June 26-29, 2001
International Conference on Building Envelope Systems and Technologies
Ottawa, ON
Tel: 613-993-0435
Fax: 613-952-7673



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